Chapter 6

Ventricular Rhythms

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Objectives

- Describe the ECG characteristics, possible causes, signs and symptoms, and emergency management for the following dysrhythmias that originate in the ventricles:
  a. Premature ventricular complexes (PVCs)
  b. Ventricular escape beats
  c. Ventricular escape (idioventricular) rhythm (IVR)
  d. Accelerated idioventricular rhythm (AIVR)
  e. Ventricular tachycardia (VT)
  f. Polymorphic VT
  g. Torsades de pointes (TdP)
  h. Ventricular fibrillation (VF)
  i. Asystole

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Objectives

- Explain the terms *bigeminy*, *trigeminy*, *quadrigeminy*, and *"run"* when used to describe premature complexes
- Explain the difference between premature ventricular complexes and ventricular escape beats
- Explain the terms *monomorphic* and *polymorphic ventricular tachycardia*
- Discuss long QT syndrome (LQTS)

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Objectives

- State the purpose and procedure for defibrillation
- List the indications for defibrillation
- Explain the term *P-wave asystole*
- Explain the term *pulseless electrical activity*

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Ventricular Rhythms

- The ventricles are the heart's least efficient pacemaker
  - Intrinsic rate of 20-40 bpm

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Ventricular Rhythms

- The ventricles may assume responsibility for pacing the heart if:
  - The SA node fails to discharge
  - An impulse from the SA node is generated but blocked as it exits the SA node
  - The rate of discharge of SA node is slower than that of ventricles
  - An irritable site in either ventricle produces an early beat or rapid rhythm

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Ventricular Depolarization

- Ventricular beats and rhythms may originate from any part of the ventricles
- Typically characterized by QRS complexes that are abnormally shaped and prolonged (>0.12 sec)

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Ventricular Repolarization

- Because ventricular depolarization is abnormal, ventricular repolarization is also abnormal
  - Results in changes in ST segments and T waves
- T waves are usually in a direction opposite that of the QRS complex

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Premature Ventricular Complexes

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PVC—How Do I Recognize It?

- Arise from an irritable focus within either ventricle
- A PVC:
  - Occurs earlier than the next expected sinus beat
  - QRS is typically ≥0.12 sec
  - T wave is usually in the opposite direction of the QRS complex

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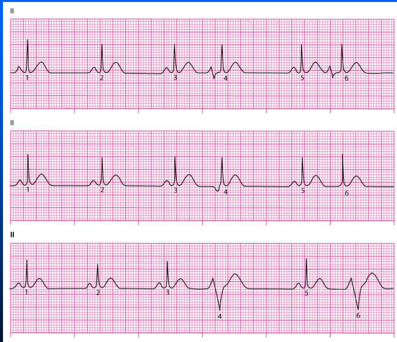
PVC—How Do I Recognize It?



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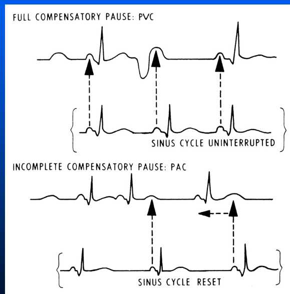
PVC—How Do I Recognize It?

- A full compensatory pause often follows a PVC



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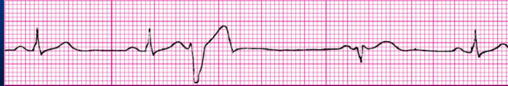
Fusion Beats

- Result from an electrical impulse from a supraventricular site (such as the SA node) firing at the same time as an ectopic site in the ventricles
- Do not resemble normally conducted beats, nor do they resemble true ventricular beats



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PVCs—Patterns

- Pairs (couplets): 2 sequential PVCs
- Runs or bursts: ≥ 3 sequential PVCs
- Bigeminal PVCs (ventricular bigeminy): every other beat is a PVC
- Trigeminal PVCs (ventricular trigeminy): every 3rd beat is a PVC
- Quadrigeminal PVCs (ventricular quadrigeminy): every 4th beat is a PVC

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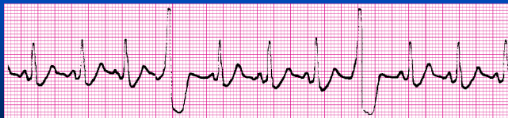
PVC—How Do I Recognize It?

- Uniform PVCs
  - Premature ventricular beats that look the same in the same lead and originate from the same anatomical site (focus)



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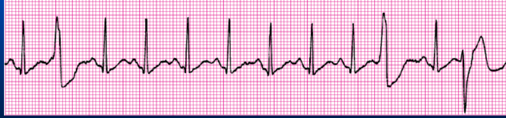
PVC—How Do I Recognize It?

- Multiform PVCs
  - PVCs that appear different from one another in the same lead
  - Often (but not always) arise from different anatomical sites



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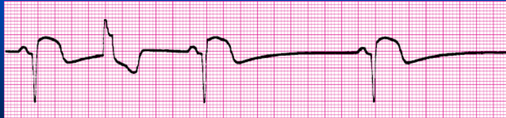
PVC—How Do I Recognize It?

- Interpolated PVCs
  - Do not have a full compensatory pause
  - "Squeezed" between two regular complexes without disturbing the underlying rhythm



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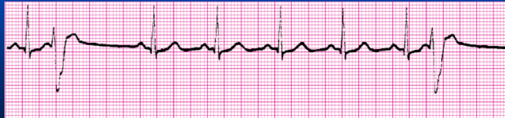
PVC—How Do I Recognize It?

- R-on-T PVCs
  - Occur when the R wave of a PVC falls on the T wave of the preceding beat
  - A PVC occurring during this period of the cardiac cycle can cause VT or VF



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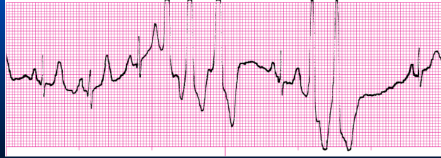
PVC—How Do I Recognize It?

- Pairs and runs
  - 2 PVCs in a row are called a “couplet” or “paired PVCs”
  - ≥3 PVCs in a row at a rate of more than 100 bpm are called a “salvo,” “run,” or “burst” of VT



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PVC—How Do I Recognize It?

Rate	Usually WNL, but depends on underlying rhythm
Rhythm	Essentially regular with premature beats; if the PVC is an interpolated PVC, the rhythm will be regular
P waves	Usually absent or, with retrograde conduction to the atria, may appear after the QRS (usually upright in the ST-segment or T wave)
PR interval	None with the PVC because the ectopic originates in the ventricles
QRS	>0.12 sec, wide and bizarre; T wave usually in opposite direction of QRS complex

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PVC—What Causes It?

- Can occur in healthy persons with apparently normal hearts and with no apparent cause
- Incidence of PVCs increases with age

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PVC—What Causes It?

- Normal variant
- Hypoxia
- Stress, anxiety
- Exercise
- Digitalis toxicity
- Acid-base imbalance
- Myocardial ischemia
- Electrolyte imbalance
- Congestive heart failure
- Increased sympathetic tone
- Acute coronary syndromes
- Stimulants
- Medications
  - Sympathomimetics
  - Cyclic antidepressants
  - Phenothiazines

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PVC—What Do I Do About It?

- Patients may be asymptomatic or complain of:
  - Palpitations
  - "Racing heart"
  - Skipped beats
  - Chest or neck discomfort
- If PVCs are frequent, signs of decreased cardiac output may be present

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PVC—What Do I Do About It?

- Treatment of PVCs is dependent on the:
  - Cause
  - Patient's signs and symptoms
  - Clinical situation

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Ventricular Escape Beats

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Ventricular Escape Beat—How Do I Recognize It?

- Occurs after a pause in which a supraventricular pacemaker failed to fire
  - QRS measures ≥0.12 sec
  - Occurs late in the cardiac cycle, appearing after the next expected sinus beat
  - Protects the heart from more extreme slowing or even asystole

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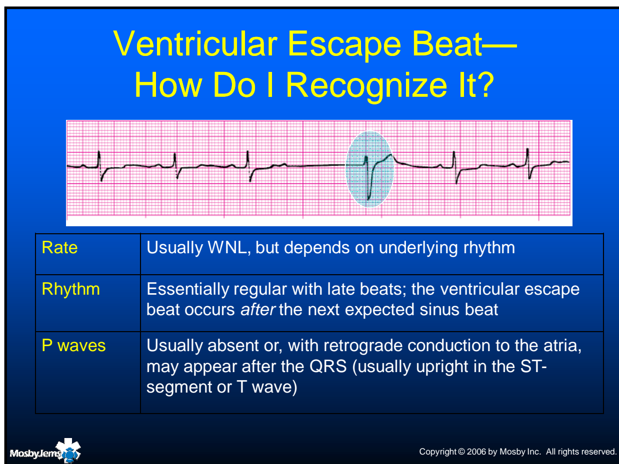
Ventricular Escape Beat—How Do I Recognize It?



Rate	Usually WNL, but depends on underlying rhythm
Rhythm	Essentially regular with late beats; the ventricular escape beat occurs *after* the next expected sinus beat
P waves	Usually absent or, with retrograde conduction to the atria, may appear after the QRS (usually upright in the ST-segment or T wave)

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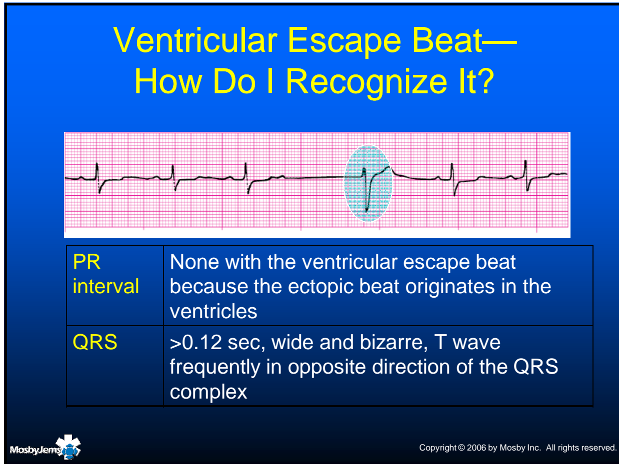

Ventricular Escape Beat—How Do I Recognize It?

Rate	Usually WNL, but depends on underlying rhythm
Rhythm	Essentially regular with late beats; the ventricular escape beat occurs *after* the next expected sinus beat
P waves	Usually absent or, with retrograde conduction to the atria, may appear after the QRS (usually upright in the ST-segment or T wave)
PR interval	None with the ventricular escape beat because the ectopic beat originates in the ventricles
QRS	>0.12 sec, wide and bizarre, T wave frequently in opposite direction of the QRS complex

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Ventricular Escape Rhythm

also known as
Idioventricular Rhythm (IVR)

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IVR—How Do I Recognize It?

- IVR is three or more ventricular escape beats occurring in a row at a rate of 20-40 bpm
- "Agonal rhythm"
  - Ventricular rate <20 bpm

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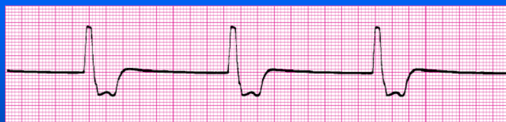
IVR—How Do I Recognize It?



Rate	20-40 bpm
Rhythm	Essentially regular
P waves	Usually absent or, with retrograde conduction to the atria, may appear after the QRS (usually upright in ST-segment or T wave)

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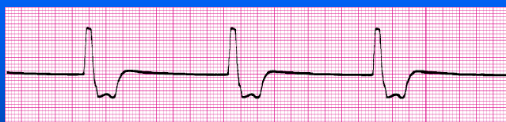
IVR—How Do I Recognize It?



PR interval	None
QRS	>0.12 sec, T wave frequently in opposite direction of QRS complex

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IVR—How Do I Recognize It?

Rate	20-40 bpm
Rhythm	Essentially regular
P waves	Usually absent or, with retrograde conduction to the atria, may appear after the QRS (usually upright in ST-segment or T wave)
PR interval	None
QRS	>0.12 sec, T wave frequently in opposite direction of QRS complex

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IVR—What Causes It?

- IVR may occur when:
  - The SA node and AV junction fail to initiate an electrical impulse
  - The rate of discharge of the SA node or AV junction becomes less than the intrinsic rate of the ventricles
  - Impulses generated by a supraventricular pacemaker site are blocked
- IVR may also occur because of MI, digitalis toxicity, or metabolic imbalances

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IVR—What Do I Do About It?

- Slow rate and loss of atrial kick may result in signs of decreased cardiac output
- If the patient has a pulse and is symptomatic because of the slow rate:
  - Transcutaneous pacing (TCP)

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Pulseless Electrical Activity (PEA)

- PEA is a clinical situation, not a specific dysrhythmia
- PEA exists when organized electrical activity (other than VT) is present on the cardiac monitor, but the patient is apneic and pulseless

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PEA—Causes

- Pulmonary embolism
- Acidosis
- Tension pneumothorax
- Cardiac tamponade
- Hypovolemia (most common cause of PEA)
- Hypoxia
- Heat/cold (hypothermia/hyperthermia)
- Hypokalemia/hyperkalemia (and other electrolytes)
- Myocardial infarction
- Drug overdose/accidents (cyclic antidepressants, calcium channel blockers, beta-blockers, digoxin)

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PEA—Causes

- Patient is unresponsive, apneic, and pulseless
- Prognosis is dismal unless cause is identified and rapidly treated
- CPR
- Oxygen, tracheal intubation, IV access
- Search aggressively for possible cause(s)
- Medications per current resuscitation guidelines

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Accelerated Idioventricular Rhythm (AIVR)

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AIVR—How Do I Recognize It?

- AIVR exists when three or more ventricular escape beats occur in a row at a rate of 41-100 bpm
  - Some cardiologists consider the ventricular rate range of AIVR to be 41-120 bpm

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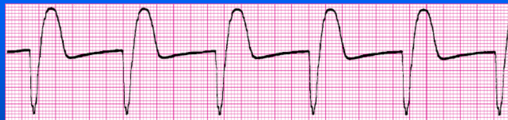
AIVR—How Do I Recognize It?



Rate	41-100 bpm
Rhythm	Essentially regular
P waves	Usually absent or, with retrograde conduction to the atria, may appear after the QRS (usually upright in ST-segment or T wave)

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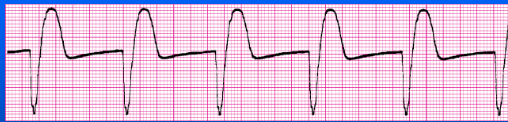
AIVR—How Do I Recognize It?



PR interval	None
QRS	>0.12 sec, T wave frequently in opposite direction of the QRS complex

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AIVR—How Do I Recognize It?

Rate	41-100 bpm
Rhythm	Essentially regular
P waves	Usually absent or, with retrograde conduction to the atria, may appear after the QRS (usually upright in ST-segment or T wave)
PR interval	None
QRS	>0.12 sec, T wave frequently in opposite direction of the QRS complex

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AIVR—What Causes It?

- Usually considered a benign escape rhythm
  - Appears when the sinus rate slows and disappears when the sinus rate speeds up
- Often seen during first 12 hours of MI
- Common after successful reperfusion therapy

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AIVR—What Causes It?

- Digitalis toxicity
- Cocaine toxicity
- Subarachnoid hemorrhage
- Acute myocarditis
- Hypertensive heart disease
- Dilated cardiomyopathy

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AIVR—What Do I Do About It?

- Treatment usually unnecessary
- If the patient is symptomatic because of the loss of atrial kick:
  - Atropine may be ordered
  - Atrial pacing may be attempted

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Ventricular Tachycardia (VT)

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VT—How Do I Recognize It?

- VT exists when three or more PVCs occur in in a row at a rate of more than 100 bpm
  - Nonsustained VT
    - A short run lasting <30 sec
  - Sustained VT
    - Persists for >30 sec

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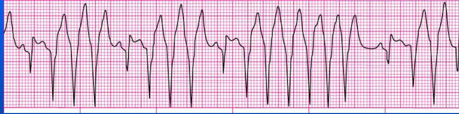
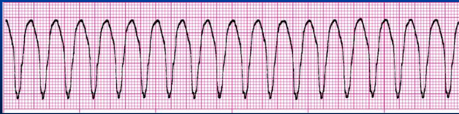
VT—How Do I Recognize It?

- Nonsustained VT



- Sustained VT



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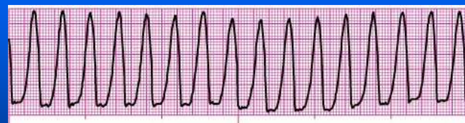
VT—How Do I Recognize It?

- Monomorphic VT



Rate	101-250 bpm
Rhythm	Essentially regular
P waves	May be present or absent; if present, they have no set relationship to the QRS complexes appearing between the QRS's at a rate different from that of the VT

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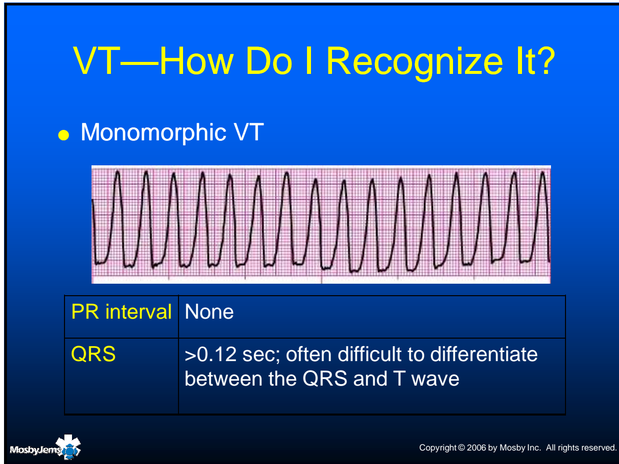

VT—How Do I Recognize It?

- Monomorphic VT

Rate	101-250 bpm
Rhythm	Essentially regular
P waves	May be present or absent; if present, they have no set relationship to the QRS complexes appearing between the QRS's at a rate different from that of the VT
PR interval	None
QRS	>0.12 sec; often difficult to differentiate between the QRS and T wave

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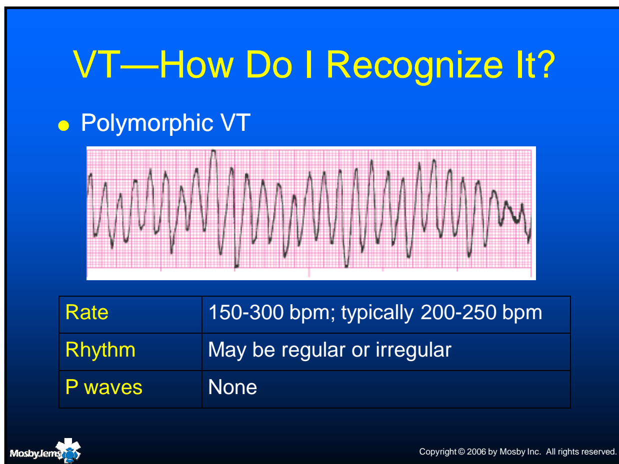
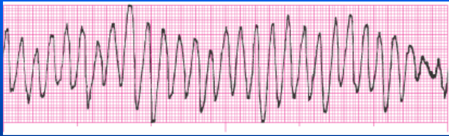


VT—How Do I Recognize It?

- Polymorphic VT



PR interval	None
QRS	>0.12 sec; gradual alteration in amplitude and direction of the QRS complexes; a typical cycle consists of 5-20 QRS complexes

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VT—How Do I Recognize It?

Rate	150-300 bpm, typically 200-250 bpm
Rhythm	May be regular or irregular
P waves	None
PR interval	None
QRS	>0.12 sec; gradual alteration in amplitude and direction of the QRS complexes; a typical cycle consists of 5-20 QRS complexes

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VT—How Do I Recognize It?

- Polymorphic VT – types
  - Normal QT
  - Long QT syndrome (LQTS)
    - Acquired (iatrogenic)
    - Congenital (idiopathic)

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VT—How Do I Recognize It?

- Polymorphic VT that occurs in the presence of a long QT interval
  - Torsades de pointes (TdP)
- Polymorphic VT that occurs in the presence of a normal QT interval
  - Polymorphic VT

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VT—What Causes It?

- Acute coronary syndromes
- Cardiomyopathy
- Tricyclic antidepressant overdose
- Digitalis toxicity
- Valvular heart disease
- Cocaine abuse
- Mitral valve prolapse
- Acid-base imbalance
- Trauma
  - Myocardial contusion
  - Invasive cardiac procedures
- Electrolyte imbalance
  - Hypokalemia
  - Hyperkalemia
  - Hypomagnesemia

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VT —What Do I Do About It?

- Signs and symptoms vary
- Syncope or near-syncope may occur because of an abrupt onset of VT
  - The patient’s only warning symptom may be a brief period of lightheadedness

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VT—What Do I Do About It?

- Treatment is based on the patient's signs and symptoms and the type of VT
- Severity of symptoms depend on:
  - How rapid the ventricular rate is
  - How long the tachycardia has been present
  - Presence and extent of underlying heart disease

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Important Note

- A supraventricular tachycardia with an intraventricular conduction delay may be difficult to distinguish from VT
- If you are unsure whether a regular, wide-QRS tachycardia is VT or SVT with an intraventricular conduction delay, treat the rhythm as VT until proven otherwise

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Ventricular Fibrillation (VF)

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VF—How Do I Recognize It?

- Chaotic rhythm that begins in the ventricles
- No organized depolarization of the ventricles
  - Ventricular myocardium quivers
  - No effective myocardial contraction and no pulse
  - No normal-looking waveforms are visible

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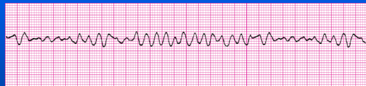
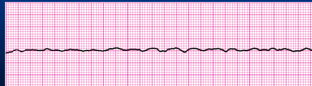
VF—How Do I Recognize It?

- Coarse VF
  - Waves easily visible (≥3 mm)



- Fine VF
  - Low amplitude waves (<3 mm)



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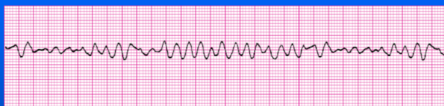
VF—How Do I Recognize It?



Rate	Cannot be determined because there are no discernible waves or complexes to measure
Rhythm	Rapid and chaotic with no pattern or regularity
P waves	Not discernible
PR interval	Not discernible
QRS	Not discernible

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VF—What Causes It?

- Increased sympathetic nervous system activity
- Vagal stimulation
- Electrolyte imbalance
- Antiarrhythmics and other medications
- Hypertrophy
- Acute coronary syndromes
- Heart failure
- Arrhythmias
- Environmental factors (e.g., electrocution)

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VF—What Do I Do About It?

- CPR until a defibrillator is available
- Defibrillate as soon as defibrillator arrives
- Perform tracheal intubation
- Establish IV access
- Continue resuscitation effort per current resuscitation guidelines

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Defibrillation

- Purpose of defibrillation is to produce momentary asystole
- Shock attempts to completely depolarize the heart
  - Provides an opportunity for the heart's natural pacemakers to resume normal activity

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Defibrillation—Indications

- Pulseless VT
- Ventricular fibrillation

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Defibrillation

- Power on defibrillator
- Place paddles or self-adhesive defib pads on patient's chest
  - If using manual defibrillator paddles, apply firm pressure
- Select the appropriate energy level for the rhythm
- Charge paddles, recheck ECG rhythm
- Look (360°) to be sure the area is clear
  - Call "Clear!"
- Depress both discharge buttons simultaneously to deliver shock
- Reassess the rhythm

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Asystole

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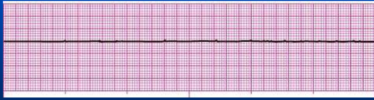
Asystole—How Do I Recognize It?

- Asystole is a total absence of ventricular electrical activity
  - There is no ventricular rate or rhythm, no pulse, and no cardiac output



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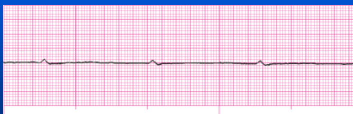
Asystole—How Do I Recognize It?

- Some atrial electrical activity may be evident
  - "P-wave" asystole



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Asystole—How Do I Recognize It?

Rate	Ventricular usually not discernible but atrial activity may be seen ("P-wave" asystole)
Rhythm	Ventricular not discernible, atrial may be discernible
P waves	Usually not discernible
PR interval	Not measurable
QRS	Absent

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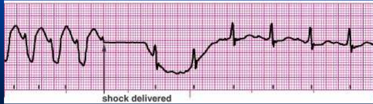
Asystole—What Causes It?

- Causes of asystole are the same as PEA
- Asystole may occur temporarily following termination of a tachycardia with medications, defibrillation, or synchronized cardioversion



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Asystole—What Do I Do About It?

- Treatment of asystole includes:
  - Confirmation of the absence of a pulse
  - Immediate CPR
  - Confirmation of the rhythm in two leads
  - Tracheal intubation
  - IV access
  - Consideration of the possible causes of the rhythm
  - Possible use of transcutaneous pacing
  - Medications per current resuscitation guidelines

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Questions?

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